

[54] **DEVICE FOR AN INFINITE ADJUSTMENT OF THE SPECIMEN STROKE IN MICROTOMES AND ULTRAMICROTOMES**

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[58] Field of Search: 83/703, 707, 414, 83/915.5

[56] **References Cited**

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[57] **ABSTRACT**

A microtome having continuous adjustment to vary the length of the specimen cutting stroke is provided by a pair of eccentric members mounted on a drive shaft with one eccentric member selectively positionable about the periphery of the other eccentric member in order to provide a continuous range of eccentricity with a corresponding adjustment range in the specimen stroke. A cam may be also connected to the drive shaft and adjustable about the drive shaft to operate a switch for controlling the return stroke of the specimen arm. In motor driven microtomes, a means for varying the cutting and/or return stroke speed is desirable to accommodate long and short cutting strokes and provide consistent tissues.

10 Claims, 8 Drawing Figures

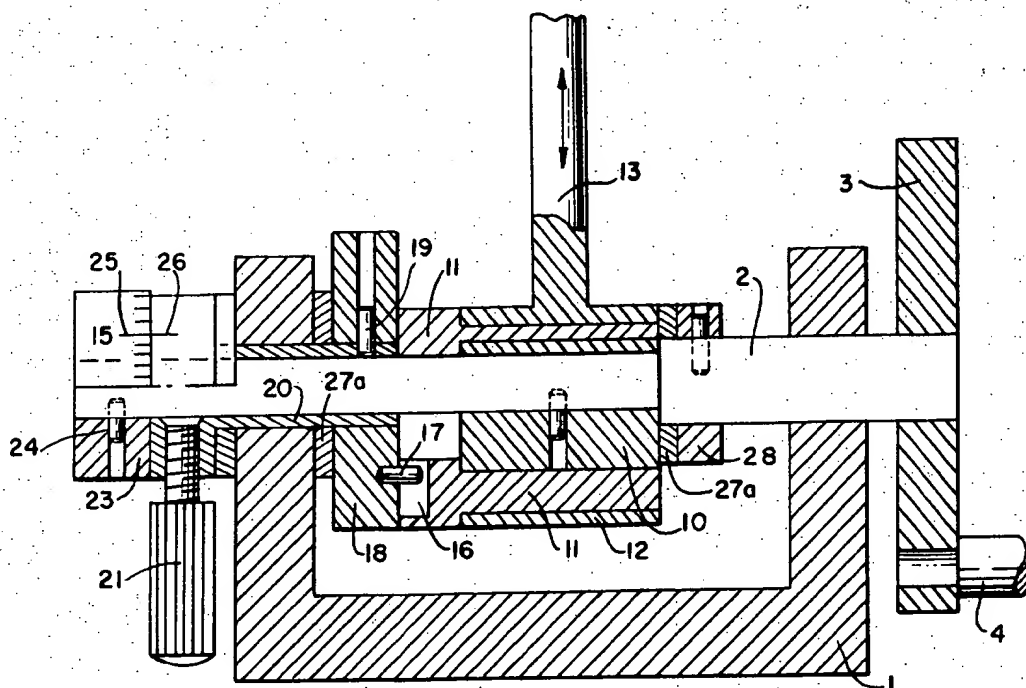


FIG. 1.

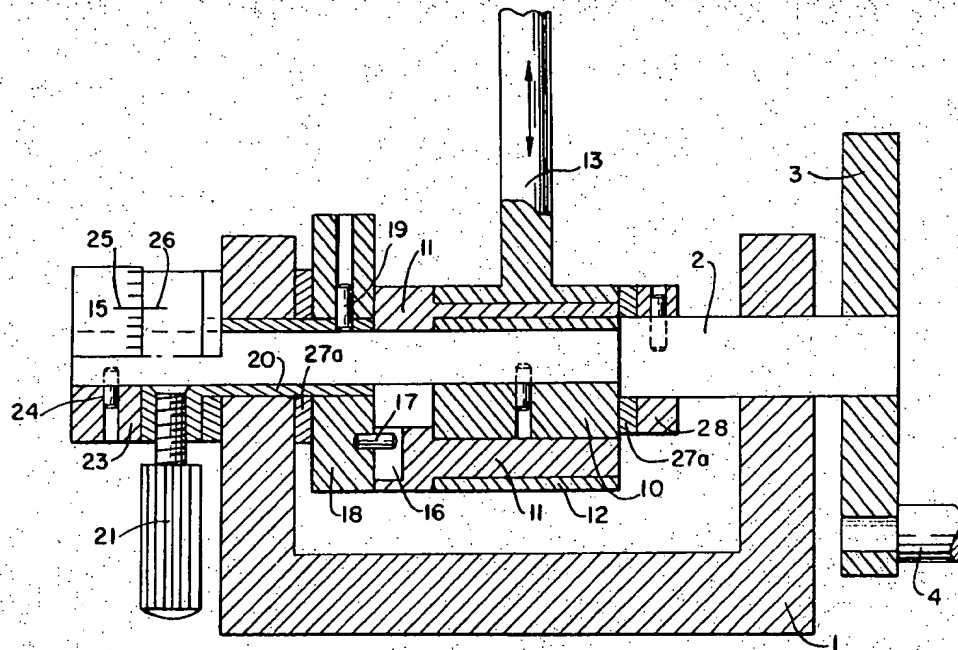


FIG. 1a.

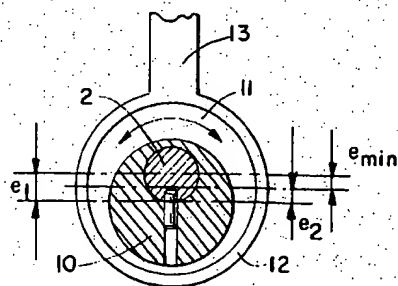
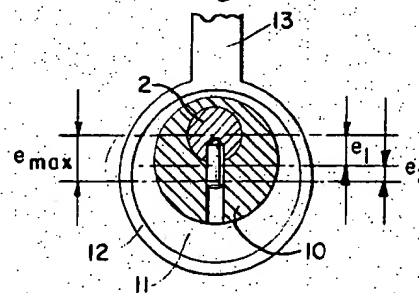


FIG. 1b.



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FIG. 2a.

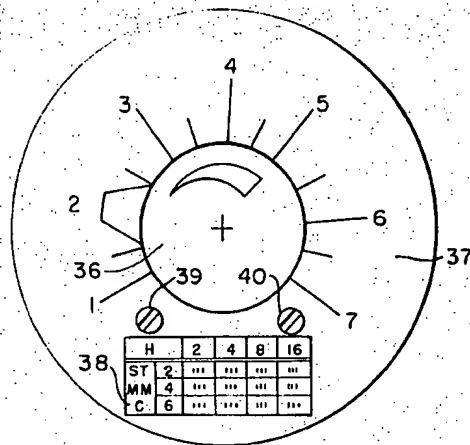


FIG. 2b.

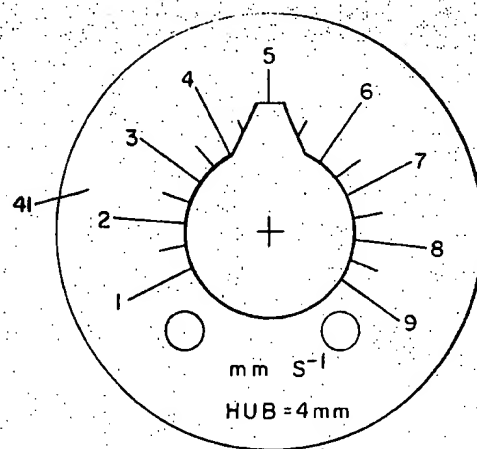


FIG. 3a.

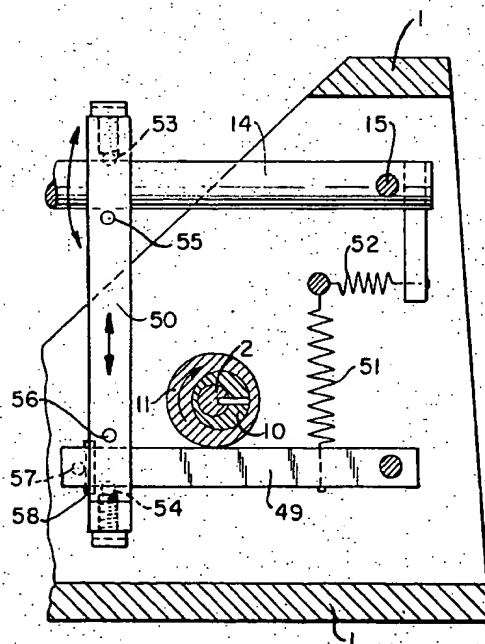
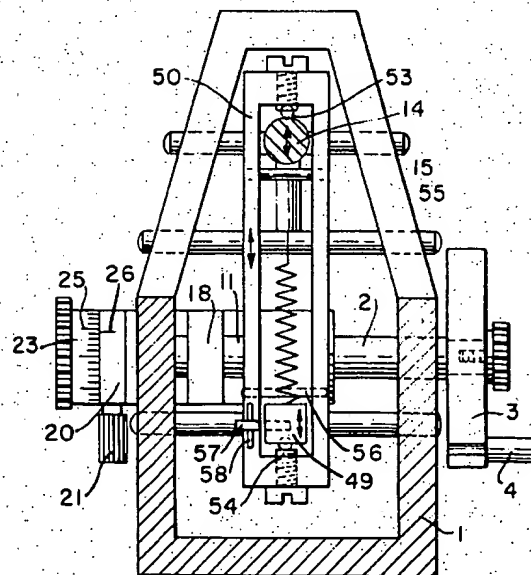


FIG. 3b.



DEVICE FOR AN INFINITE ADJUSTMENT OF THE SPECIMEN STROKE IN MICROTOMES AND ULTRAMICROTOMES

BACKGROUND OF THE INVENTION

This invention relates to microtomes and ultramicrotomes. More particularly, the present invention relates to means for changing the stroke of the specimen in microtomes and ultramicrotomes.

Different embodiments of various cutting instruments for cutting tissue sections having a thickness of about 0.05 micron to and above 50 microns are known. For making ultrathin sections or even thin sections having a thickness of about 0.05-5 microns, so-called ultramicrotomes are used having a specimen stroke which is selected based upon conventional specimens, which are usually about 5 millimeters in diameter. The specimen arm stroke is not adjustable and for most instruments is within a range of 5-10 millimeters. The linear velocity of the specimen, which is important and related to said stroke, is usually restricted to less than about 5 millimeters per second. Excessively high linear velocities result in microvibrations during the cutting of some specimens such as adipose tissue, which can be cut only with difficulty, and when certain kinds of knives are used, such as diamond knives. These microvibrations produce wrinkles or surface undulations in the specimens when cutting is done at higher specimen velocities. Sections cut at high velocities which suffer from the aforementioned defects are not suitable for examination with an electron microscope and are generally discarded.

In view of the constant section thickness, which must be maintained by cutting instruments, these instruments must have high mechanical standards. Both the cutting knife and the specimen holder, which is mounted at the free end of a specimen carrier arm, are usually arranged to be universally adjustable.

The so-called thin-section microtomes are used for making sections having a thickness of about 0.5-50 microns. These thin-section microtomes are usually mechanically simpler and satisfy less stringent specifications since extreme consistency of specimen thickness is not as critical. For instance, such thin-section microtomes have simplified knife holder having fewer adjustments and the specimen is received by a specimen holder which can be adjusted in a simple manner. The specimen is moved by a slide, which is slidable, e.g., in a dovetail guide, so that in view of the generally larger specimen diameters of about 20 millimeters, the specimen motion of the cutting stroke is much larger than that of ultramicrotomes and is in the order of about 40 millimeters.

For this reason, instruments for cutting thin sections cannot be used to make ultrathin sections even if they were mechanically accurate.

It is thus not possible to use the same instrument for making both ultrathin sections and also thin sections. This is considered very inconvenient because two cutting instruments must be available for making cuts having thicknesses throughout the range of 0.5-50 microns and the investment costs of such instruments frequently cannot be economically justified, particularly if the number of thin sections to be made is small with respect to the number of ultrathin sections to be made.

It is important to note that electron-optical examinations are increasingly supplimented by light-optical examinations for comparison and confirmation purposes and ultramicrotomes are increasingly used to make preparations for light-optical examinations, particularly when the same are to be conducted at or near the limit of resolving power of the light-optical system.

DESCRIPTION OF THE INVENTION

It is an object of the present invention to provide a simple device which can be embodied in cutting instruments for making ultrathin sections of small specimens and that said instruments can also perform cutting of larger specimens requiring longer specimen strokes into sections providing thicknesses embracing the entire thickness range of thin sections. This object is accomplished by having at least two control elements for moving the specimen which are mounted on a drive shaft. One of the control elements is connected directly to the drive shaft and moves in unison therewith, while the other control element is indirectly mounted on the drive shaft and is adapted to be adjustable with respect to both the first control element and the drive shaft.

When such devices are embodied in ultramicrotomes, that is instruments suitable for making ultrathin sections, these instruments can also be used to make thin sections from larger specimens. These improved ultramicrotomes are suitable for cutting both thin and ultrathin sections without need for other mechanical alterations, without adversely affecting the subsequent use of the instruments to make ultrathin sections, and without significantly increasing costs, and, at the same time, the accuracy that is required to cut useful ultrathin sections is maintained. An optimum adjustment of the cutting operation to the specific cutting condition is now possible. In cutting good sections efficiently, short strokes at low linear velocities are required when diamond knives are used in order to obtain extremely small surfaces of cut, whereas a longer stroke is required when the same specimen is cut with a glass knife and higher linear velocities are possible so that the operation can be performed more rapidly. It is also desirable to be able to cut a large specimen requiring a long stroke at a low linear velocity.

According to the invention, two control elements are eccentrically mounted to form a drive means. One eccentric member is movably mounted on a second eccentric member so that a double eccentric with respect to the drive shaft controls the length specimen stroke. This embodiment excels by virtue of being particularly simple, compact and reliable. The eccentric members are independently rotatable relative to each other and can be individually locked into any position relative to the drive shaft by at least one locking element, such as a screw, pin, or the like. As a result, the desired eccentricity of the double eccentric can be adjusted by repositioning either or both of the eccentric members. The two eccentric members can also be adjusted to provide for optimum dynamic balance of the drive shaft and eccentric drive means.

Further advantages and features of the invention will be explained more fully hereinafter with reference to the drawing showing illustrative embodiments to which the invention is not restricted.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view showing the eccentric drive means, partly in section, according to the invention.

FIGS. 1a and 1b are side views of the double eccentric drive means in the two extreme positions of adjustment.

FIG. 2 shows one mechanism of the present invention as embodied in a modified cutting instrument, which is additionally provided with means for controlling the return movement of the specimen and means for controlling a variable speed transmission.

FIGS. 2a and 2b illustrate useful dials which may be used to supplement the invention for indicating the specimen stroke.

FIGS. 3a and 3b are, respectively, end and front sectional views showing a device according to the invention in a cutting instrument.

PREFERRED EMBODIMENT

In the drawings, base 1 carries drive shaft 2 which is rotatably mounted and to which rotation can be imparted by the handwheel 3. The handwheel 3 can be manually driven using handle 4 or by means of an electric motor 5 (FIG. 2) and drive belt 8 trained around belt pulley 6 at the motor and conforming groove 7 in handwheel 3. The belt drive may be replaced by a conventional geared transmission or a variable speed transmission. The speed is preferably infinitely variable either at the motor or at the transmission.

A specimen stroke control consisting of an eccentric member 10 is connected to the drive shaft 2 by a key (not shown) or pin 9 and rotates in unison with the shaft. Eccentric member 10 carries a second eccentric member 11, which can be manually rotated on the eccentric member 10. Connecting rod 13 is rotatably mounted on eccentric member 11 with bearing sleeve 12 so that the eccentricity of the entire system can be varied. Connecting rod 13 is pivotably connected to the specimen carrier arm 14 (FIG. 3) between the specimen (not shown) and bearing 15. The motion of the connecting rod imparts a substantially vertical up and down motion to the specimen end of carrier arm 14.

If as shown in FIG. 1a, the eccentric member 10 has eccentricity e_1 and the eccentric member 11 has eccentricity e_2 which is, for instance, smaller than e_1 , the shortest stroke, e_{\min} of connecting rod 13 will be equal to $e_1 - e_2$ and the longest stroke, e_{\max} , of connecting rod 13 will be $e_1 + e_2$, as shown in FIG. 1b.

The stroke can be adjusted to any length between e_{\min} and e_{\max} by incremental rotation of the eccentric member 11 around eccentric member 10. It will be understood, of course, that each of members 10 and 11 can be rotated independently of the other and the movement of the two eccentric members 10 and 11 can be in unison.

Adjustment to a predetermined stroke is accomplished by an actuating element consisting of a drive wheel, rotary mandrel or the like. As exemplified, eccentric member 11 has a radially extending groove 16, which is adapted to cooperate with pin 17 mounted on coupling member 18, which is rigidly connected to adjusting sleeve 20.

Adjusting sleeve 20 is enlarged at the outer end to carry locking element 21, so that the adjusting sleeve 20 and with it the eccentric member 11 can be manually locked in any desired position relative to the drive

shaft 2 and/or the eccentric disc 10 mounted on the drive shaft 2. The locking element also assists in the operation in accurately positioning adjusting sleeve 20.

Graduated knob 23 is used to manually adjust eccentric member 10 relative to drive shaft 2 and is detachably secured to the drive shaft 2 by pin 24. The graduated knob 23 is provided on its periphery, with a scale 25, which in cooperation with a pointer or mark 26 on the enlarged portion of adjusting sleeve 20 enables one to make an exact check or reproduce an adjustment of the specimen stroke. The scale may be designed so that the specimen stroke can be read directly in desired units, i.e. mm. Also, the scale may be on a ring, which is fitted over the periphery of drive wheel 23 and indexed as most desirable. The interchangeability of the scale has the advantage that it enables the value of the actual stroke of the specimen to be indicated in different units, such as millimeters, inches, etc. as desired.

Collar 27 is provided to hold the eccentric members 20 in their positions of adjustment and one or more pressure discs 27a are forced against the eccentric members by the collar or pressing against bearing (not shown) in the housing. As a result, the various elements serving to adjust the stroke are self-locking. The pressure discs 27a may be thrust spring-loaded so that there is no need for periodic adjustment or readjustment of pressure and the required friction will be automatically maintained.

The specimen stroke is set in a simple manner by loosening lock screw 21 and manually rotating adjusting sleeve 20 relative to drive shaft 2. Lock screw 21 may be designed to serve as a handle to assist in imparting the rotational movement. Drive shaft 2 is manually held in fixed position by means of the handwheel 3 during rotation to adjust eccentricity. The desired specimen stroke can be verified by reference to the position of the scale relative to the reference mark 26. After the adjustment has been set, adjusting sleeve 20 is locked in position on the drive shaft by lock screw 21.

If the specimen should be moved at different velocities during its cutting and/or return movements, or if the specimen should be pulled back after the cut opposite to the direction in which it has been fed during the cut, it will be suitable within the scope of the invention to mount the required control elements also on the drive shaft 2 carrying eccentric members 10 and 11. Preferably, such control elements include cam 29, which cooperates with a control unit, such as, a reversing microswitch 30, which controls the variable speed transmission when cutting and return movements are performed at different velocities.

To enable an adjustment of the variable speed transmission and the return movement when desired, cam 29 is connected to sleeve 31, which is rotatably mounted on drive shaft 2 and connected to handwheel 3. The setting is shown and reproduceability is possible because element 32, which is secured to drive shaft 2, carries a scale 33. Cooperating mark or pointer 34 is provided on the flat face of the handwheel 3 to indicate the value reflected by the setting. Knurled knob 35 serves to lock element 32 relative to the handwheel 3 after the adjustment has been made.

The arrangement of the control means for adjusting the stroke of the means for controlling other movements of the specimen on a common drive shaft affords advantages in that very compact structure is possible and all movement can be generated and coordinated by

a single component common to all operations in order that errors of transmission and adjustment are minimized.

In motor-driven cutting instruments utilizing the present invention, the optimum relationship between the motor speed, length of stroke, and cutting velocity can be presented in a simple, clear manner to any operation. For this purpose, a disc 37 having a reference chart should be provided on the knob 36 which is used for controlling the speed of the motor.

One embodiment of such disc is shown enlarged in FIG. 2a. In addition to a scale for the rotary knob 36 used to adjust the absolute linear speed, the disc is provided with a chart or tabel 38, from which the rotary speed and the stroke velocity can be read for strokes of various lengths, e.g., of 2, 4, 8, and 16 millimeters depending on the linear velocity. It will also be desirable to provide discs 41 which are replaceable and can be fitted for each standard stroke frequently used, such as 5 millimeters. As shown in FIG. 2b, disc 41 is simply fitted over the rotary knob 36 and held in position by pins or screws 39 and 40.

To assist adjustment of the specimen stroke and the variable speed transmission, a shaft locking mechanism is provided, which includes locking member 42, which mates with collar 43 connected to the shaft 2. Alternatively, the locking member 42 may engage shaft 2 directly in the recess 44. This locking member is usually operated by a rotatable handle 45, which is mounted on the shaft 46 carrying cam 47, which cooperates with locking member 42 to move the same against the force of the spring 48 in response to manual actuation of the handle 45. When inoperative, locking member 42 is urged by the spring 48 against the portion 47a of the cam 47 and is thereby disengaged from collar 43 or the drive shaft 2 so that the latter may freely rotate.

FIGS. 3a and 3b show one preferred embodiment of the present invention. In accordance with FIG. 3a, eccentrics 10 and 11 act directly on lever 49 which imparts to the specimen carrier arm 14 by means of connecting link 50 a stroke of a length which has been determined by adjustment of the eccentric. In view of the strong force required to cut thin sections of large area from polyester or epoxide blocks, the entire mechanical structure is designed to exert a downward cutting stroke and lever 49 is disposed below the eccentric 11. Spring 51 holds lever 49 in engagement with the eccentric to eliminate backlash and holds the specimen carrier arm 14 in constant engagement with the adjustable bearing formed by ball 53, which is mounted on connecting link 50. Connecting link 50 also carries the ball 54, which is adjustable in height and forms a lower bearing for lever 49. Lock pins 55 and 56 are located near spherical bearings 63 and 54, respectively, and prevent dislocation connecting link 50 from the spherical bearings.

Bearing elements consisting, e.g., of steel needle bearings 57 and 58 are provided on the lever 49 and on connecting link 50, which embraces the specimen carrier arm 14 and the lever 49 on both sides. These steel needles prevent rotation of the connecting link on its spherical bearings. Such rotation would cause inaccuracies during adjustment as well as reduce the ability to obtain specific results from a particular setting.

Numerous modifications are possible within the scope of the invention. For instance, the variable speed transmission provided just as the concentric eccentrics

on the drive shaft need not be controlled by means of a cam and a reversing microswitch, such as are illustrated in the drawings, although that design and arrangement has proved particularly satisfactory. Such control may also be accomplished by a light barrier and various light stops, which have configurations related to the configuration of the cam 29.

What is claimed is:

1. A microtome having an adjustable stroke comprising a body, a knife mounted on said body, a specimen holder arm, said arm being pivotably mounted on said body at one end and adapted to hold a specimen adjacent said knife at the other end, a rotatable drive shaft mounted on said body, means carried on said drive shaft to oscillate said specimen holder arm, said means including first and second members, the first member being eccentrically attached to said drive shaft, the second member being eccentrically positioned about the periphery of said first member, manually operable means to rotate said second member about said first member to a selected eccentric position with respect to said first member, releasable lock means to couple said first and second members to provide a maximum eccentricity equal to the total eccentricity of said first and second members and a minimum eccentricity equal to the eccentricity of said first member less the eccentricity of said second member.

2. A microtome according to claim 1 wherein said manually operable means includes a sleeve enclosing a portion of the periphery of said drive shaft, means carried on one end of said sleeve to rotatably couple said sleeve to said second member and means attached to the other end of said sleeve to carry said lock means.

3. A microtome according to claim 2 wherein said first member is a cylinder secured to said drive shaft and has a cylindrical axis parallel to and spaced from said drive shaft and said second member is a hollow cylinder having a bore adapted to mate with the periphery of said first member, said bore having an axis parallel to and spaced from the cylindrical axis of said second member.

4. A microtome according to claim 3 wherein said lock means is a manually-rotatably, threaded member radially mounted in a flange on said sleeve and adapted to engage said drive shaft, an index means on said flange and a cylindrical seal attached to the end of said drive shaft adjacent one end of said flange and cooperating with said indexing means.

5. A microtome according to claim 4 wherein said sleeve has a second flange at the one end of said sleeve adjacent to said member, said second member has a radially extending recess in an end thereof and said second flange has an axially-aligned, eccentrically-positioned pin member adapted to cooperate with said recess to rotate said second member when said sleeve is manually rotated.

6. A microtome of claim 3 further including a collar mounted on the drive shaft and adapted to rotate therewith, said collar having a radially extending bore opening through the periphery, a member movable mounted on said body and adapted to normally rest in a position spaced from said collar, and manually operable means to move a portion of said member into said bore to temporarily prevent rotation of said drive shaft during adjustment of said second member.

7. A microtome according to claim 5 further including a collar mounted on the drive shaft and adapted to

rotate therewith, said collar having a radially extending bore opening through the periphery, a member movably mounted on said body and adapted to normally rest in a position spaced from said collar, and manually operable means to move a portion of said member into said bore to temporarily prevent rotation of said drive shaft during adjustment of said second member.

8. A microtome according to claim 3 further including a motor means for rotating said drive shaft and means for controlling the return stroke of said specimen arm having adjustable switching means for signaling the shift of said specimen arm from cutting stroke

to return stroke.

9. A microtome according to claim 7 further including a motor means for rotating said drive shaft and means for controlling the return stroke of said specimen arm having adjustable switching means for signaling the shift of said specimen arm from cutting stroke to return stroke.

10. A microtome according to claim 9 further including means for varying the speed at which said drive shaft is rotated during the cutting stroke.

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